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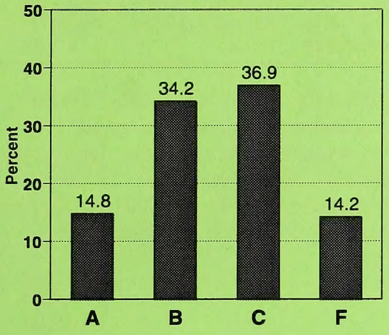
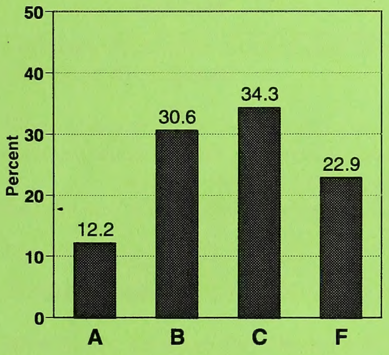
Mathematics 33

Diploma Examination Results
Examiners' Report for January 1998

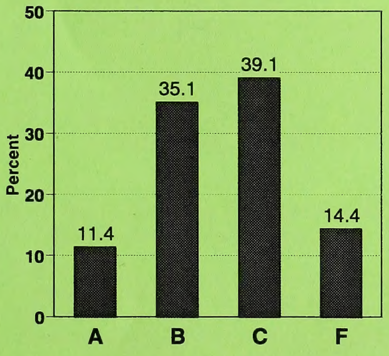
School-Awarded Mark



Diploma Examination Mark



Final Course Mark



The summary information in this report provides teachers, school administrators, and students with an overview of results from the January 1998 administration of the Mathematics 33 Diploma Examination. This information is most helpful when used with the detailed school and jurisdiction reports that have been provided electronically to schools and school jurisdiction offices. A provincial report containing a detailed analysis of the combined November, January, June, and August results is made available annually.

Description of the Examination

The Mathematics 33 Diploma Examination consists of 37 multiple-choice questions worth 53%, 12 numerical-response questions worth 17%, and four written-response questions worth 30% of the total examination.

Achievement of Standards

The information reported is based on the final course marks achieved by 5 581 students who wrote the January 1998 examination.

- 85.6% of the 5 581 students achieved the acceptable standard (a final course mark of 50% or higher).
- 11.4% of the students achieved the standard of excellence (a final course mark of 80% or higher).

Approximately 50.7% of the students who wrote the January 1998 examination were female.

- 86.8% of the female students achieved the acceptable standard (a final course mark of 50% or higher).
- 14.5% of the female students achieved the standard of excellence (a final course mark of 80% or higher).

Approximately 49.3% of the students who wrote the January 1998 examination were male.

- 84.4% of the male students achieved the acceptable standard (a final course mark of 50% or higher).
- 8.2% of the male students achieved the standard of excellence (a final course mark of 80% or higher).

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Provincial Averages

- The average school-awarded mark was 63.6%.
- The average diploma examination mark was 61.2%.
- The average final course mark, representing an equal weighting of the school-awarded mark and the diploma examination mark, was 62.8%.

Of the 5 581 students who wrote the January 1998 examination, 325 had written at least one Mathematics 33 Diploma Examination previously.

Results and Examiners' Comments

In the table below, machine-scored diploma examination questions are classified by question type: multiple choice (MC) and numerical response (NR). The correct answer for each question is provided under the column labelled "Key" and the proportion (out of 1) of students answering the question correctly is provided under the column labelled "Difficulty." The "Difficulty" is the mean score achieved on a question by all students who wrote the examination. Questions are also classified by unit topic and mathematical understanding. The abbreviations for these areas are expanded in results that follow the table.

Blueprint

Question	Key	Difficulty	RF	Q	PR	RE	TR	ST	AML	Math Und.
MC1	D	0.935	✓							C
NR1	360	0.908	✓							P
NR2	3.74	0.871			✓					P
WR1	-	0.540		✓		✓				PCPS
MC2	A	0.497					✓			P
NR3	280	0.772					✓			P
MC3	D	0.481	✓							C
MC4	A	0.599					✓			C
MC5	B	0.347				✓				PS
NR4	44	0.886	✓							C
MC6	A	0.729	✓							C
NR5	556	0.542							✓	PS
NR6	8003	0.224							✓	P
MC7	D	0.576						✓		PS
WR2	-	0.490						✓		PCPS
MC8	C	0.388			✓					P
MC9	B	0.822			✓					C
NR7	107	0.527			✓					P
MC10	D	0.609			✓					P
MC11	C	0.679			✓					PS
NR8	10	0.676				✓				C
MC12	C	0.658				✓				P
MC13	A	0.683				✓				P
MC14	B	0.516				✓				P
MC15	C	0.642		✓						C
NR9	18.0	0.612					✓			PS
NR10	6.4	0.614					✓			P
MC16	B	0.667	✓							P
MC17	D	0.683					✓			P
MC18	C	0.553					✓			PS
MC19	C	0.521		✓						PS
MC20	B	0.645	✓							C

Question	Key	Difficulty	RF	Q	PR	RE	TR	ST	AML	Math Und.
MC21	D	0.453	✓							C
NR11	340	0.626	✓							PS
NR12	75	0.778						✓		P
MC22	D	0.907	✓							PS
MC23	A	0.554						✓		P
WR3	-	0.694	✓							PCPS
MC24	B	0.706							✓	PS
MC25	A	0.665							✓	C
MC26	C	0.670		✓						C
MC27	C	0.863		✓						C
MC28	A	0.363		✓						PS
MC29	D	0.410	✓							PS
MC30	A	0.842						✓		C
MC31	C	0.860						✓		C
WR4	-	0.476	✓				✓			PCPS
MC32	B	0.593					✓			PS
MC33	B	0.923							✓	PS
MC34	D	0.623					✓			P
MC35	C	0.407	✓							C
MC36	B	0.442		✓						P
MC37	B	0.628		✓						C

Subtests: Machine Scored and Written Response (Average by Subtest)

When analyzing detailed results, please bear in mind that subtest results **cannot** be directly compared.

Results are in average raw scores.

Machine scored: 31.3 out of 49

Written response: 11.5 out of 21

Raw Score Average for Machine-Scored Questions by Course Emphasis

RF	Relations and Functions	8.1	out of	12
Q	Quadratic Functions and Equations	4.1	out of	7
PR	Powers and Radicals	3.9	out of	6
RE	Polynomials and Rational Expressions	2.9	out of	5
TR	Trigonometry	5.8	out of	9
ST	Statistics	3.6	out of	5
AML	Annuities, Mortgages, and Loans	3.1	out of	5

Raw Score Average for Machine-Scored Questions by Mathematical Understanding*

Procedural (P):	11.1	out of	18
Conceptual (C):	11.8	out of	17
Problem Solving (PS):	8.4	out of	14

*Refer to Appendix D of the 1997 - 98 *Mathematics 33 Information Bulletin, Diploma Examinations Program*, for an explanation of mathematical understandings.

The means on written-response questions are lower than the means on machine-scored questions. The group of students achieving the standard of excellence (80% or higher or A) on the whole examination had a mean of 86.5% on the machine-scored questions as compared to 80.3% on the written-response questions. The group of students achieving between 50% and 79% (B or C) on the whole examination scored a mean of 66.8% on the machine-scored questions, which is higher than the 57.8% they scored on the written-response questions. The group of students below the acceptable standard (49% or less, or F) on the whole examination had a mean of 43.3% on the machine-scored questions compared to 32.4% on the written-response questions. The strengths and weaknesses of student responses on the written-response questions are discussed later in this report. An analysis of these can be used to maximize student performance on written-response questions.

Multiple-Choice and Numerical-Response Questions

Questions on the examination were grouped around scenarios or practical situations that occur in real life. For the January 1998 Mathematics 33 Examination, personnel from the Edmonton Space and Science Centre, Northern Alberta Institute of Technology, Canmore Nordic Center, and Canada Olympic Park assisted teachers in the development of questions and scenarios. The multiple-choice, numerical-response, and written-response questions were mixed within the scenarios of the examination, and where appropriate, questions from the same unit of the course were organized together.

The machine-scored section of the examination requires mathematics students to demonstrate conceptual, procedural, and problem-solving understanding of the mathematical content of the course. During the marking session, markers agreed that the machine-scored questions were appropriate and very fair. They also concurred that the questions were reasonably demanding, expecting students to meet the curriculum standards related to the general outcomes for Mathematics 33, especially those pertaining to communication, estimation, and application to real life.

Percentage of Students Correctly Answering Machine-Scored Questions

	Question Number							
Student Group	**MC9**	**NR7**	**MC 10**	**MC11**	**MC4**	**MC20**	**MC19**	**MC36**
All Students	82.2	52.7	60.9	67.9	59.9	64.5	52.1	44.2
Students achieving the *standard of excellence* (80% or higher, or A) on the whole examination	98.7	85.9	95.2	94.7	79.3	91.8	80.9	67.3
Students achieving the *acceptable standard* marks (between 50% and 79%, B or C) on the whole examination	87.5	57.6	64.9	73.8	63.1	69.2	53.9	44.8
Students who have not achieved the *acceptable standard* (49% or less, or F), on the whole examination	58.6	21.3	31.4	38.3	40.7	36.8	32.7	30.3

9. To rationalize the denominator of $\frac{\sqrt{5}}{4\sqrt{3}}$, the **best** strategy is to multiply the numerator and denominator by

A. $\sqrt{2}$
***B.** $\sqrt{3}$
C. $\sqrt{5}$
D. $\sqrt{10}$

Numerical Response

7. If $\sqrt{18} + 2\sqrt{50} + a\sqrt{2} = 120\sqrt{2}$, then the value of a is 107.
(Record your answer on the answer sheet.)

A discussion on how well students met the curriculum standards related to algebra follows. Curricular expectations are that students be able to generalize, connect, and describe relationships between algebraic and graphical representations. As well, students are required to connect their algebraic understandings to operations, and to equations involving rational expressions or radicals. Compared to the past, students in Mathematics 33 are demonstrating stronger abilities and understanding related to algebraic manipulation and generalization. In the year before the first Mathematics 33 Diploma examination, statistics from field tests revealed that most students achieving an acceptable standard but not the standard of excellence, were not handling the algebraic abstraction that occurred in routine operations related to radical and rational expressions, and some teachers believed that only students achieving the standard of excellence would be able to handle such algebraic abstraction. However, teachers did agree that the majority of students achieving the acceptable standard should be able to solve questions involving some degree of algebraic abstraction or generalization.

10. The expression $\left(\sqrt{a} - 3\sqrt{2}\right)\left(\sqrt{a} + 3\sqrt{2}\right)$, where $a > 0$, is equivalent to

- **A.** $2\sqrt{a} - 18\sqrt{2a}$
- **B.** $a - 18\sqrt{a}$
- **C.** $2a + 18$
- ***D.** $a - 18$

11. The solution for x in the equation $\sqrt{x - 3} = b$, where $b > 0$ and $x > 3$, is

- **A.** $b + 3$
- **B.** $b - 3$
- ***C.** $b^2 + 3$
- **D.** $b^2 + 9$

Use the following information to answer the next question.

Students in electronics technology studies learned that a carrier wave is a radio wave of constant amplitude and frequency. A carrier wave can be represented by the sine function $y = a \sin b\theta$.

4. The parameter in the function that alters the amplitude of its graph is

- ***A.** a
- **B.** b
- **C.** y
- **D.** θ

Use the following information to answer the next question.

Contractors carpeted two **square** rooms near the theatre. One side of the larger square room is 6 m longer than a side of the smaller square room. The **total** area of the two square rooms is 260 m^2.

19. If the length, in metres, of a side of the smaller square room is represented by x, then an equation that could be used to determine x is

- **A.** $x(x + 6) = 260$
- **B.** $x(x - 6) = 260$
- ***C.** $x^2 + (x + 6)^2 = 260$
- **D.** $(x + 6)^2 + (x - 6)^2 = 260$

This expectation has been confirmed by the results of the January 1998 examination, which indicate that students achieving the acceptable standard are handling algebraic abstraction, manipulation, and generalization well. Questions without these components appear to be very easy for the Mathematics 33 students. Of all the students writing the examination, 82.2% correctly answered multiple-choice question 9, a non-algebraic routine radical operation question. In comparison, numerical-response question 7 and multiple-choice question 10 are non-routine questions that require understanding of symbol substitution and manipulation. A majority of students were successful in answering numerical-response question 7 (52.7%) and multiple-choice question 10 (60.9%). Multiple-choice question 11 required students to solve for *x* in terms of another variable, *b*, and students were very successful (67.9% overall) in fulfilling this expectation.

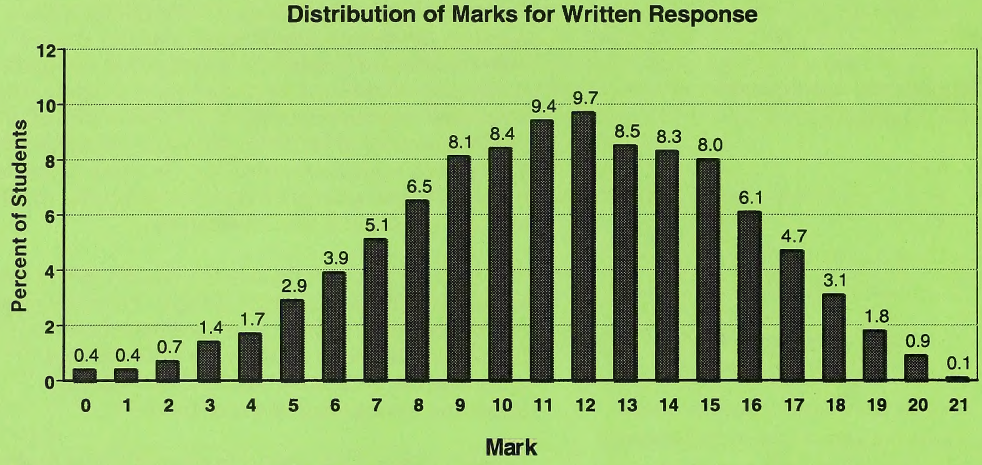
The table on page 4 indicates the success rate of the various student achievement groups. From the table, it can be seen that the algebraic questions discussed thus far discriminate very strongly between students achieving the acceptable standard and students achieving the standard of excellence.

Another expectation related to algebra is that students demonstrate understanding of the relationships between algebraic functions and graphs. From these understandings, they should be able to build generalizations. It is apparent from the results of multiple-choice questions 4 and 20, which required students to demonstrate understanding of these generalizations, that students are strong in this area.

However, results indicate students are still not strong in the area of formulating and solving algebraic equations. Multiple-choice question 19 required students to formulate an equation from a real-life situation, and multiple-choice question 36 required students to solve an equation that had already been formulated. Such questions have traditionally had a low success rate. Formulating equations and solving word problems is an area that constantly needs to be worked on. When compared with other groups, students achieving the standard of excellence are good at formulating equations for word problems, as was required in multiple-choice question 19. It should be noted, however, that all students were weak in solving equations such as that in multiple-choice question 36.

Written-Response Questions

The graph below shows the percentage of students achieving various marks on the written-response questions. The maximum mark obtainable was 21. Questions in the written-response section dealt with five of the seven content strands for Mathematics 33. Students achieving the acceptable standard were expected to obtain at least half of the possible marks on all questions. Students achieving the standard of excellence were expected to get almost full marks.

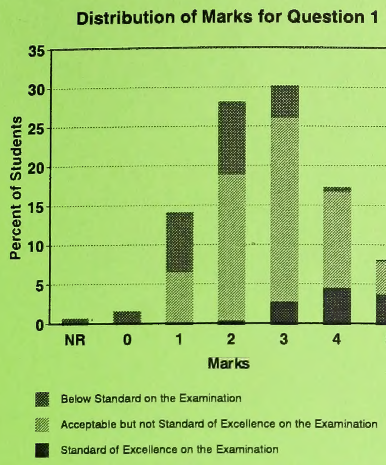


Below, the results of the written-response section of the Mathematics 33 Diploma Examination are tabulated according to the percentage of students from each group attaining the standards on each question.

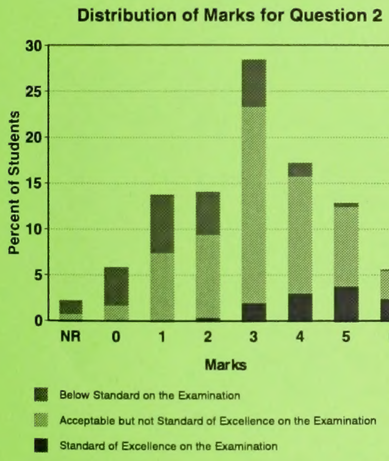
Percentage of Students Achieving the Standards on Written-Response Questions

Student Group	Question Number WR 1	WR 2	WR 3	WR 4
Students achieving the *acceptable standard* (A, B, and C) who achieved 50% or higher on the question	66.2	74.3	85.4	61.7
Students at the *standard of excellence* (A) who achieved 80% or higher on the question	70.7	52.3	86.3	66.4
Students at the *acceptable standard* but not at the *standard of excellence* (B and C) who achieved a grade between 50% and 79% on the question	60.8	70.5	83.3	56.1

The written-response section is worth 30% of the total examination mark. Students are expected to use conceptual, procedural, and problem-solving understandings to solve the four written-response questions. Teachers can compare school and jurisdiction results with the provincial results presented in the graphs that follow to determine areas of strengths and weaknesses in the achievement of their students and, consequently, areas of potential strengths and weaknesses in their program.



Question 1 required students to communicate understanding of what non-permissible values are for rational expressions, and to use the quadratic formula to solve a rational equation. The question was marked on a five-point holistic scale and the average was 2.7 (54.0%). Overall, markers felt student responses to the question were done well. There were very few "no responses" and "zeros" (responses that do not show any significant understanding). The strength of student responses was that they were clear in demonstrating what was required. Markers commented that at least two-thirds of the students supplied supporting detail, such as "division by zero is not possible," when defending non-permissible values, and that most students proficiently demonstrated the algebraic manipulation required to solve the equation in part c. Weaknesses in student responses were related to communication and application of the quadratic formula. In some of the weaker responses ideas about non-permissible values were expressed unclearly, and poor attention was paid to detail. In general, mistakes made using the quadratic formula were copying and substitution errors, (especially when substituting into the "–*b*" term). Careless syntax errors, such as using the variable *x* in place of *k*, were also a concern.



Question 2 required students to determine confidence intervals and demonstrate understanding related to a statistical design problem. The question was marked on a six-point anaholistic scale: a one-point scale for the confidence interval statement and a five-point scale for the problem-solving and statistical design understandings communicated. The average for this question was 2.94 (49.0%). There were very few "no responses" to this question. Teachers indicated that student responses showed strong ability in reading tables and using box plots. Students also demonstrated strong understanding of the impact of bias and population size in statistical experiments. The main weakness in the student responses to this question was the poor communication of ideas; for example, failing to distinguish between sampling and survey errors, and poor articulation and/or lack of concluding statements.

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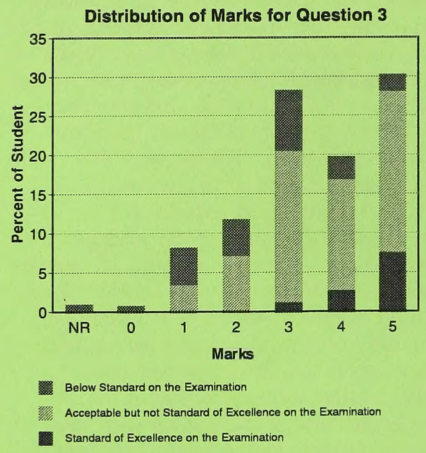
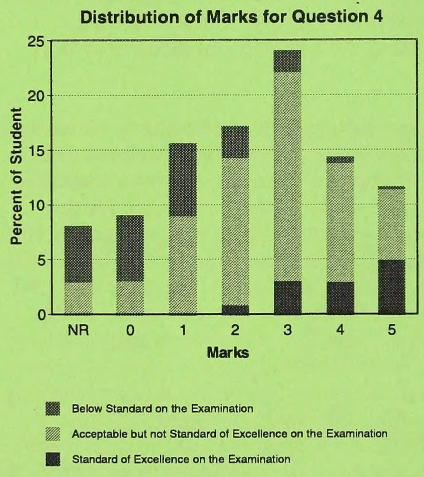

Distribution of Marks for Question 3

Question 3 required students to solve a problem linked to interpreting real-life graphs that could be used for financial decision-making. Associated skills required the student to demonstrate understandings, make comparisons, and communicate answers. The question was marked on a five-point holistic scale and the average was 3.47 (69.4%). Students demonstrated strengths in reading graphs and drawing inferences from a graph. However, interpretations or inferences were not always communicated well. The lack of complete sentences, misuse of precise terminology, lack of proper syntax (dollar signs), and absence of adequate justification were identified as the main communication weaknesses. As well, students appeared to be inexperienced with the use of directing words such as compare and contrast, and many students failed to justify or tie their graph comparisons to numerical evidence. Teachers suggested that students need to practice more questions that use directing words in order to strengthen performance on this type of question.


Distribution of Marks for Question 4

Question 4 required students to apply their knowledge of triangles and to use skills such as estimation, prediction, analysis, and calculation to solve a problem. The question was marked on a five-point holistic scale and the average was 2.38 (47.6%). When compared with other written-response questions on this examination, question 4 had a higher percentage of "no responses" and "zeros." In previous administrations, Mathematics 33 students have had difficulty with open-ended questions related to triangles. Teachers marking question 4 reported that student responses demonstrated competence in applying either a trigonometric ratio, the Pythagorean theorem, or the sine law. Students were also proficient in laying out and bringing proper closure (statements with units) to a solution. Markers commented positively about the variety of strategies students used to solve this problem. Weaknesses in student responses were identified as conceptual errors (not selecting the appropriate triangles to solve the problem), procedural errors (using the wrong operation or procedure in solving a trigonometric ratio), and communication errors (using *x* to represent every unknown in the problem and the misuse of equal signs). As well, responses to question 4 demonstrated that students were unfamiliar with responding to directing words. Teachers again advised that students should be engaged in routine practice of the use of directing words in classroom exercises and assessment instruments. This is good advice and would enhance student performance on the written-response section of an examination.

For further information, contact Ron Flaig(rflaig@edc.gov.ab.ca) or Corinne McCabe (cmcabe@edc.gov.ab.ca) at the Student Evaluation Branch at 427-0010. To call toll-free from outside of Edmonton, dial 310-0000.

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